

REMARKS

The Applicants respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow. Claims 1-22 are pending in the present application. Claims 1-22 were rejected. Claims 1-4, 9, and 14-18 have been amended. No new matter has been added by this amendment. Accordingly, Claims 1-22 are pending in the present application.

This amendment adds, changes and/or deletes claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier.

Claim Rejections – 35 U.S.C. § 102

On page 2 of the Office Action, Claims 1-14 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,549,995 to Tanaka et al. The Applicants respectfully traverse this rejection.

Independent Claim 1 recites, among other limitations, “the first trench having a first depth for phase-shifting light having a first wavelength and the second trench having a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength,” which is not identically disclosed by Tanaka et al.

Independent Claim 9 recites, among other limitations, “the first plurality of trenches having a first depth for phase-shifting light having a first wavelength . . . the second trenches has a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength,” which is not identically disclosed by Tanaka et al.

Accordingly, independent Claims 1 and 9 require a mask that includes trenches formed at two different depths such that light of a first wavelength may be phase-shifted utilizing trench(es) having a first depth and light of a second wavelength may be phase-shifted utilizing trench(es) having a second depth that is deeper than the first depth. One

advantageous feature of such an arrangement is that a single mask may be used with different wavelengths of light.

Paragraph [0005] on page 2 of the present Specification provides the following description of phase-shifting mask technology:

Phase-shifting mask technology refers to a photolithographic mask which selectively alters the phase of the light passing through certain areas of the mask to take advantage of destructive interference to improve resolution and depth of focus. For example, in a simple case, each aperture in the phase-shifting mask transmits light 180 degrees out of phase from light passing through adjacent apertures. This causes any light overlapping from two adjacent apertures to interfere destructively, thereby reducing any exposure in the center "dark" area beneath an opaque layer, such as chrome.

Figure 3 of the present application shows one nonexclusive exemplary embodiment in which a trench 50 having a first depth 46 and another trench 52 having a second depth 48 are provided in a transparent layer 34. Light of a first wavelength is shifted due to destructive interference between light passing through trench 50 and an adjacent area of the surface 44 of the mask 26. Light of a second wavelength is shifted due to destructive interference between light passing through trench 52 and an adjacent area of the surface 44 of the mask 26. Thus, each of the trenches 50 and 52 acts to phase-shift light of a different wavelength.

Tanaka et al. discloses a "transparent transmitting substrate 11" in which "a portion of the substrate 11 corresponding to one opening pattern is etched to a depth D_1 and that of the substrate corresponding to another opening pattern is etched to a depth D_2 " (Column 6, lines 16-20 and Figures 3A-3E).

While Tanaka et al. does disclose "opening patterns" etched to different depths (see Figure 3E), it does not disclose a mask that includes trenches having different depths such that light of a first wavelength may be phase-shifted utilizing trench(es) having a first depth and light of a second wavelength may be phase-shifted utilizing trench(es) having a second depth.

In contrast, the mask of Tanaka et al. is intended to act as a phase-shifting mask for a single wavelength of light. The adjacent “opening patterns” of Tanaka et al. are formed to have different depths such that a “phase difference of 180 degrees is caused between adjacent opening patterns” (Column 6, lines 35-36). Accordingly, the “opening patterns” are provided at differing depths to provide a phase difference for a single wavelength of light (due to the difference in depths between the opening patterns). The shallower “opening patterns” of Tanaka et al. do not, however, act to provide a phase shift for a different wavelength of light as compared to the deeper “opening patterns.”

The rejection of Claims 1-14 cannot be maintained, because at least one limitation of independent Claims 1 and 9 (and corresponding dependent Claims 2-8 and 10-14) is not identically disclosed by Tanaka et al. Accordingly, the Applicants request reconsideration and withdrawal of the rejection of Claims 1-14 under 35 U.S.C. § 102(b).

Claim Rejections – 35 U.S.C. § 103(a)

On page 2 of the Office Action, Claims 1-22 were rejected under 35 U.S.C. § 103(a) as being obvious in view of U.S. Patent No. 6,068,951 to Pierrat et al. or U.S. Patent No. 5,700,605 to Ito et al. in view of Tanaka et al. The Applicants respectfully traverse these rejections.

Independent Claim 1 recites, among other limitations, “the first trench having a first depth for phase-shifting light having a first wavelength and the second trench having a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength.”

Independent Claim 9, recites, among other limitations, “the first plurality of trenches having a first depth for phase-shifting light having a first wavelength . . . the second trenches has a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength.”

Independent Claim 15 recites, among other limitations, “the first trench having a first depth and the second trench having a second depth deeper than the first depth; transmitting

light having a first wavelength through the first trench to the photoresist layer such that the light having a first wavelength is phase-shifted; transmitting light having a second wavelength longer than the first wavelength through the second trench to the photoresist layer such that the light having a second wavelength is phase-shifted.”

Neither Pierrat et al. nor Ito et al., either alone or in proper combination with Tanaka et al., teach or suggest every element of independent Claims 1, 9, or 15.

As described above, Tanaka et al. relates to a mask intended for use with a single wavelength of light. There is no teaching or suggestion in Tanaka et al. of a mask that includes trenches formed such that light of a first wavelength may be phase-shifted utilizing trench(es) having a first depth and light of a second wavelength may be phase-shifted utilizing trench(es) having a second depth that is deeper than the first depth.

Pierrat et al. relates to a “phase shifting photomask which can be used with different wave lengths of light” (Column 2, lines 35-36). Pierrat et al. does not, however, teach or suggest a mask that includes trenches formed such that light of a first wavelength may be phase-shifted utilizing trench(es) having a first depth and light of a second wavelength may be phase-shifted utilizing trench(es) having a second depth that is deeper than the first depth. In contrast, Pierrat et al. states at Column 2, lines 62-66 (with emphasis added):

In order to design a phase shifting mask whereby a 180° phase shift is obtained at a first wave length and a 180° phase shift is obtained at a second wave length, it is necessary to find a common depth for the phase shifting layer 22 which will produce the desired phase shifts.

Thus, Pierrat et al. describes the use of a single aperture in “phase shifting layer 22” to obtain 180° phase shifts for two different wavelengths of light. Figure 1 and Column 2, lines 49-53 of Pierrat et al. describes such an arrangement. An example is described as follows at Column 3, lines 48-64 (with emphasis added):

Using a value of 7 for i_1 , it is possible to calculate a depth for the phase shifting layer which will produce a 180° phase shift for λ_1 and an approximately 180° phase shift for λ_2 . Using a value of i_2 equals 11 it is possible to obtain a depth which will

produce a 180° phase shift for λ_2 and an approximately 180° phase shift for λ_1 . In order to obtain a mask which works equally well at both wave lengths, the difference in the depths could be averaged. For i_1 equals 7, d equals 26950 Å. For i_2 equals 11, d equals 26840 Å. Since a phase change at 248 nm requires 0.634 as much depth as an equal phase change at 365 nm the compromise depth can be calculated as follows:

$$26950 + (0.634)(26850 - 26950) = 26887 \text{ Å}$$

Thus, a quartz mask having a phase shifting layer about 26890 Å deep can be used with an i-line exposure at 365 nm and a deep UV exposure at 248 nm.

Accordingly, there is no teaching or suggestion in Pierrat et al. of a mask that includes trenches formed such that light of a first wavelength may be phase-shifted utilizing trench(es) having a first depth and light of a second wavelength may be phase-shifted utilizing trench(es) having a second depth that is deeper than the first depth.

Ito et al. relates to a "light transparent substrate" that includes a "phase shift pattern" (Column 4, lines 33-39). Ito et al. does not, however, teach or suggest a mask that includes trenches formed such that light of a first wavelength may be phase-shifted utilizing trench(es) having a first depth and light of a second wavelength may be phase-shifted utilizing trench(es) having a second depth that is deeper than the first depth. In contrast, Ito et al. states at Column 4, lines 44-50 (with emphasis added):

The substrate is characterized in that it is engraved at two kinds of depth, and the difference between respective engraved amounts approximately equals an engraved amount of the shallowly engraved part. Further, the substrate is characterized in that it has the phase difference of approximate 180 degree relative to the exposure light due to the difference between respective engraved amounts.

Similar to Tanaka et al., the disclosure of Ito et al. seems to indicate that the mask described therein is intended for use with a single wavelength of light. There is no teaching or suggestion in Ito et al. that the substrate is "engraved at two kinds of depth" to allow one of the depths to shift a first wavelength of light and a second of the depths to shift a second,

different wavelength of light.

The rejection of Claims 1-22 cannot be maintained, because at least one limitation of independent Claims 1, 9, and 15 (and corresponding dependent Claims 2-8, 10-14, and 16-22) is not taught or suggested by Pierrat et al., Ito et al., or Tanaka et al., either alone or in proper combination. Accordingly, the Applicants request reconsideration and withdrawal of the rejection of Claims 1-22 under 35 U.S.C. § 103(a).

* * *

It is submitted that each outstanding objection and rejection to the Application has been overcome, and that the Application is in a condition for allowance. The Applicants request consideration and allowance of all pending Claims 1-22.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 06-1447. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 06-1447. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. § 1.136 and authorizes payment of any such extensions fees to Deposit Account No. 06-1447.

Please direct all correspondence to the undersigned attorney or agent at the address indicated below.

Respectfully submitted,

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